Attendance Problems. Convert each measurement.

1. 6 ft 3 in. to inches

2. 5 m 38 cm to centimeters

Find the perimeter and area of each polygon

3. Square with side length 13 cm

4. Rectangle with length 5.8 m and width 2.5 m

- I can use ratios to make indirect measurements.
- I can use scale drawings to solve problems.

Vocabulary		
indirect measurement	scale drawing	scale

Common Core

CC.9-12.G.SRT.4 Prove theorems about triangles.

CC.9-12.G.SRT.2 Given two figures,use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding angles and the proportionality of all corresponding pairs of sides.

Indirect measurement is any method that uses formulas, similar figures, and/or proportions to measure an object. The following example shows one indirect measurement technique.

Helpful Hint

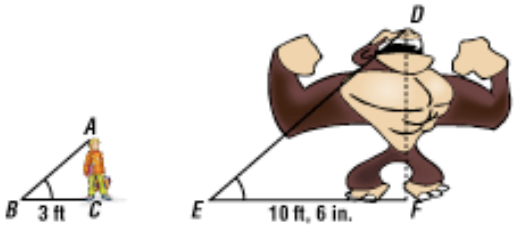
Whenever dimensions are given in both feet and inches, you must convert them to either feet or inches before doing any calculations.

Q: How many seconds are there in a year?
A: Twelve: January second, February second, March second, ...

"Conduct is more convincing than language."—*18th Century Cleric, John Woolman*

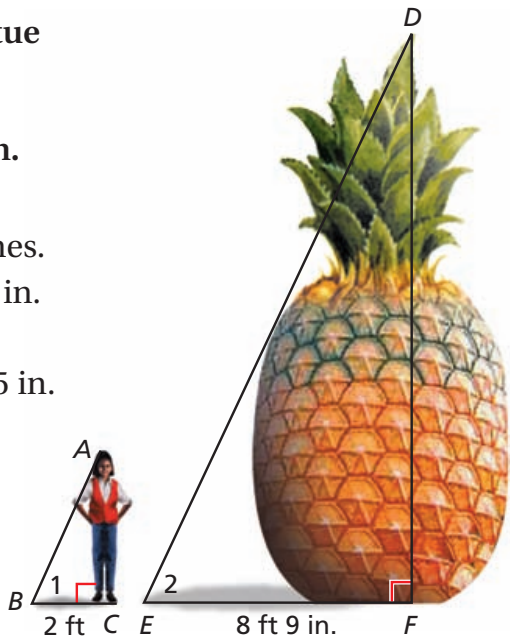
Video example 1.

A student wanted to find the height of a giant inflatable ape. She measured the ape's shadow and her own shadow and then made a diagram. The student's height is 5 ft 2 in. What is the height of the ape?



1 Measurement Application

A student wanted to find the height of a statue of a pineapple in Nambour, Australia. She measured the pineapple's shadow and her own shadow. The student's height is 5 ft 4 in. What is the height of the pineapple?



Step 1 Convert the measurements to inches.

$AC = 5 \text{ ft } 4 \text{ in.} = (5 \cdot 12) \text{ in.} + 4 \text{ in.} = 64 \text{ in.}$

$BC = 2 \text{ ft} = (2 \cdot 12) \text{ in.} = 24 \text{ in.}$

$EF = 8 \text{ ft } 9 \text{ in.} = (8 \cdot 12) \text{ in.} + 9 \text{ in.} = 105 \text{ in.}$

Step 2 Find similar triangles.

Because the sun's rays are parallel, $\angle 1 \cong \angle 2$. Therefore $\triangle ABC \sim \triangle DEF$ by $AA \sim$.

Step 3 Find DF.

$\frac{AC}{DF} = \frac{BC}{EF}$ *Corr. sides are proportional.*

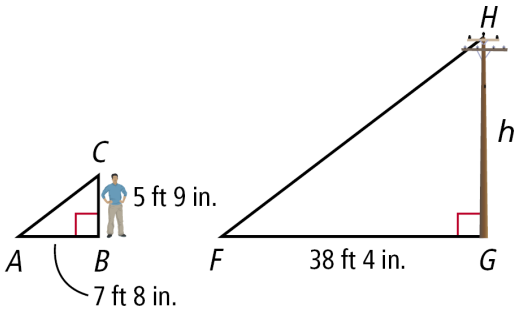
$\frac{64}{DF} = \frac{24}{105}$ *Substitute 64 for AC, 24 for BC, and 105 for EF.*

$24(DF) = 64 \cdot 105$ *Cross Products Prop.*

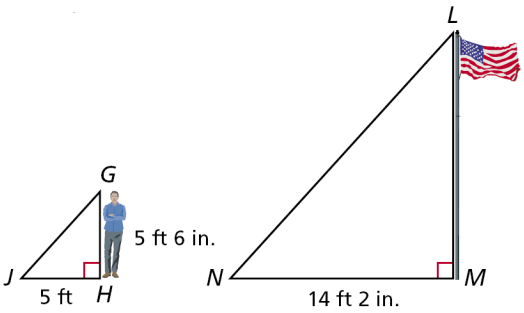
$DF = 280$ *Divide both sides by 24.*

The height of the pineapple is 280 in., or 23 ft 4 in.

Example 1. Tyler wants to find the height of a telephone pole. He measured the pole's shadow and his own shadow and then made a diagram. What is the height *h* of the pole?



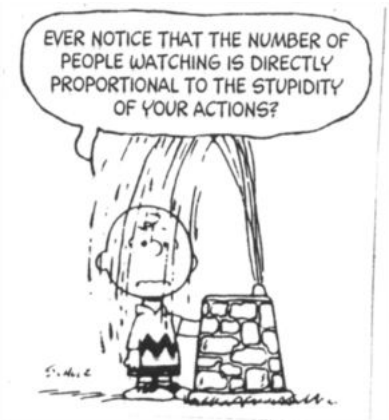
5. Guided Practice. A student who is 5 ft 6 in. tall measured shadows to find the height *LM* of a flagpole. What is *LM*?



A **scale drawing** represents an object as smaller than or larger than its actual size. The drawing's **scale** is the ratio of any length in the drawing to the corresponding actual length. For example, on a map with a scale of 1 cm : 1500 m, one centimeter on the map represents 1500 m in actual distance.

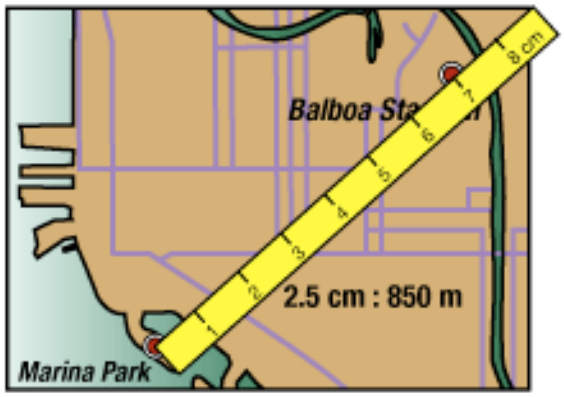
Remember!

A proportion may compare measurements that have different units.



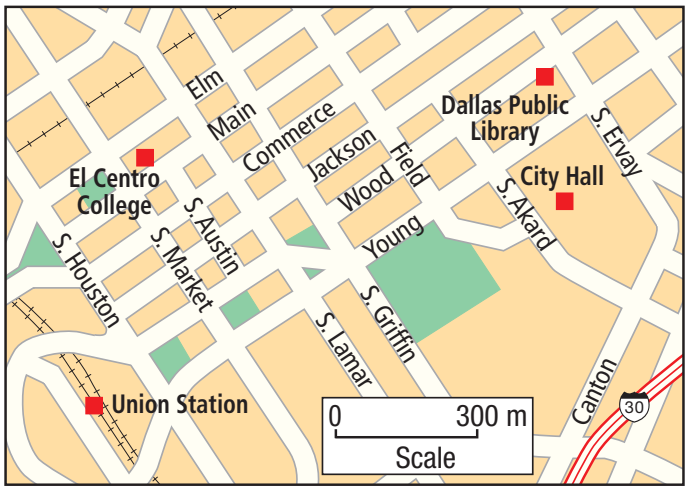
Video example 2.

The scale of this map of downtown San Diego is 2.5 cm : 850 m. Find the distance between Marina Park and the Balboa Stadium.



2 Solving for a Dimension

The scale of this map of downtown Dallas is 1.5 cm : 300 m. Find the actual distance between Union Station and the Dallas Public Library.



Use a ruler to measure the distance between Union Station and the Dallas Public Library. The distance is 6 cm.

To find the actual distance x write a proportion comparing the map distance to the actual distance.

$$\frac{6}{x} = \frac{1.5}{300}$$

$1.5x = 6(300)$ *Cross Products Prop.*

$1.5x = 1800$ *Simplify.*

$x = 1200$ *Divide both sides by 1.5.*

The actual distance is 1200 m, or 1.2 km.

Example 2. On a Wisconsin road map, Kristin measured a distance of $11\frac{1}{8}$ in. from Madison to Wausau. The scale of this map is 1inch:13 miles. What is the actual distance between Madison and Wausau to the nearest mile?

6. Guided Practice. Find the actual distance between City Hall and El Centro College.

Video example 3.

A rectangular house is approximately 20 m long and 42 m wide. Make a scale drawing of the base of the house using a scale of 2 cm : 5 m.

3 Making a Scale Drawing

The Lincoln Memorial in Washington, D.C., is approximately 57 m long and 36 m wide. Make a scale drawing of the base of the building using a scale of 1 cm : 15 m.

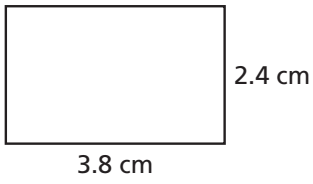
Step 1 Set up proportions to find the length ℓ and width w of the scale drawing.

$$\frac{\ell}{57} = \frac{1}{15} \qquad \frac{w}{36} = \frac{1}{15}$$

$$15\ell = 57 \qquad 15w = 36$$

$$\ell = 3.8 \text{ m} \qquad w = 2.4 \text{ cm}$$

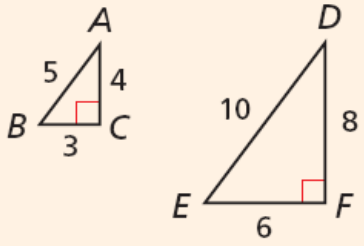
Step 2 Use a ruler to draw a rectangle with these dimensions.



Example 3. Lady Liberty holds a tablet in her left hand. The tablet is 7.19 m long and 4.14 m wide. If you made a scale drawing using the scale 1 cm:0.75 m, what would be the dimensions to the nearest tenth?

7. Guided Practice. The rectangular central chamber of the Lincoln Memorial is 74 ft long and 60 ft wide. Make a scale drawing of the floor of the chamber using a scale of 1 in.:20 ft.

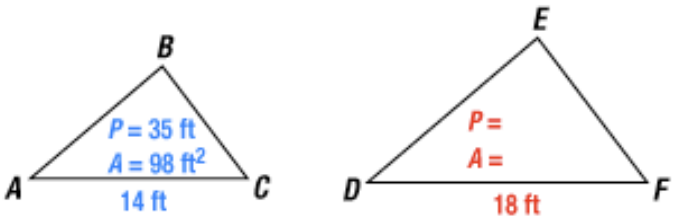
Similar Triangles **Similarity, Perimeter, and Area Ratios**

STATEMENT	RATIO
$\triangle ABC \sim \triangle DEF$ 	Similarity ratio: $\frac{AB}{DE} = \frac{AC}{DF} = \frac{BC}{EF} = \frac{1}{2}$ Perimeter ratio: $\frac{\text{perimeter } \triangle ABC}{\text{perimeter } \triangle DEF} = \frac{12}{24} = \frac{1}{2}$ Area ratio: $\frac{\text{area } \triangle ABC}{\text{area } \triangle DEF} = \frac{6}{24} = \frac{1}{4} = \left(\frac{1}{2}\right)^2$

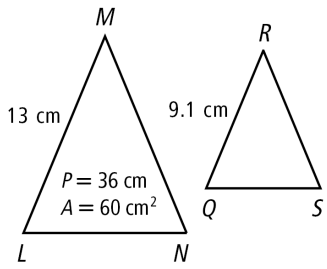
Theorem 7-5-1 **Proportional Perimeters and Areas Theorem**

If the similarity ratio of two similar figures is $\frac{a}{b}$, then the ratio of their perimeters is $\frac{a}{b}$, and the ratio of their areas is $\frac{a^2}{b^2}$, or $\left(\frac{a}{b}\right)^2$.

Refer to video example 4.
Given that the triangles are similar, find the perimeter and area.



Example 4. Given that $\Delta LMN : \Delta QRT$, find the perimeter P and area A of ΔQRS.



8. Guided Practice. $\Delta ABC \sim \Delta DEF$, $BC = 4$ mm, and $EF = 12$ mm. If $P = 42$ mm and $A = 96$ mm^2 for ΔDEF, find the perimeter and area of ΔABC.

7-5 Using Proportional Relationships *(p 505)* 12, 15, 17-20, 28, 31, 38, 40.